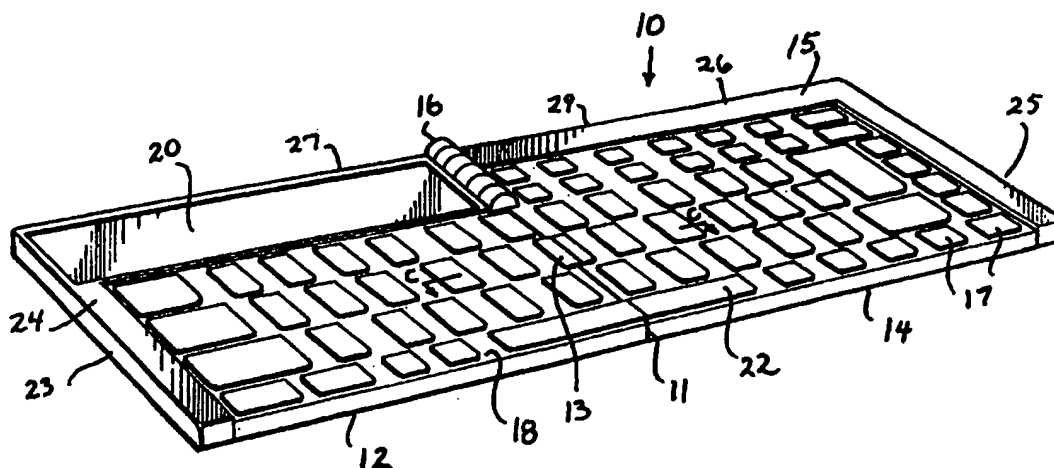


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(54) Title: POCKET COMPUTER WITH FULL SIZE KEYBOARD**(57) Abstract**

Prior miniaturized palm-top computers have reduced-size keyboards which are not useful for standard typing. The present invention provides a folding pocket-sized computer, comprising a screen, a central processing unit, data storage and input means and a full size computer keyboard. It does this by having the keyboard divided into two halves hingedly connected along a fold line. At least one of the keys may be split along the fold line to permit folding of the keyboard. A larger screen may also be obtained by folding the screen into the body of the computer when closed.

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POCKET COMPUTER WITH FULL-SIZE KEYBOARD**Technical Field**

5 The invention relates to the field of "palm top" or pocket computers and more particularly to a palm top computer having a full-size keyboard and a useful size screen.

Background Art

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For historical reasons, the standard QWERTY keyboard which was developed for mechanical typewriters remains the most common medium for inputting information to a computer. The size and spacing of the keys on such a keyboard was determined by the size of the human hand and fingers. For each key to be strongly struck a travel motion of at least 3/16" was required. The letter or symbol associated with a given key was determined by the frequency of occurrence of the different letters in the English language. Personal computers continue to use electronic equivalents of the mechanical QWERTY keyboard. Personal computers have been progressively miniaturized, so that presently pocket computers, or "palm top" computers (also referred to as "personal digital assistants") are available which are foldable to fit in the user's pocket. An example is the CASIO PEIA™ personal digital assistant. Operating systems are provided for such palm top computers such as WINDOWS/95 CE™ which allow the user to run applications software designed for personal computers. However in order to fit a keyboard into a palm top computer, the existing solution has been to miniaturize the keys of the keyboard. This makes it impossible for the user to type on the keyboard in the usual way. The screens also are very small.

United States patent no. 3,940,758, issued February 24, 1976 to Margolin, discloses an expandable keyboard for a pocket calculator, in which the keyboard pad is formed of three modular sections which are hinged together mechanically, normally forming a stack which spreads into an enlarged keyboard. However the enlarged keyboard in Margolin is still considerably smaller than a standard keyboard (the two expansion sections being 6.5 inches wide, compared to

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- 2 -

about 11 inches for a standard keyboard), and therefore use of the device for current word processing applications was clearly not contemplated, nor would calculators of that era have had the computing power and software for such uses.

A number of patents disclose hinged extensions to expand the keyboard of a notebook computer. For example, United States patent no. 5,187,644 issued February 16, 1993 and United States patent no. 5,519,569 issued May 21, 1996, both to Compaq Computer Corp. disclose portable computers of the notebook variety having extendable end segments which are hinged to the central keyboard. United States patent no. 5,457,453 issued October 10, 1995 discloses a miniature computer having a folding keyboard, which leaves a jagged edge when folded. However none of these devices provide a full size keyboard for a folding pocket computer.

There is therefore a need for a folding miniaturized computer, to allow the keyboard and screen to fit into a person's pocket, which nonetheless provides a full size keyboard and a useful screen when opened.

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Disclosure of Invention

The invention therefore provides a folding computer comprising a folding keyboard, the keyboard comprising a plurality of keys generally corresponding in spacing and location to the keys of a standard personal computer keyboard, and comprising two halves hingedly connected along a fold line, whereby the computer folds from a fully open position to a folded position wherein the two halves and associated keyboard sections face each other. According to one aspect of the invention, at least one of the keys is split along the fold line to permit folding of said keyboard. The invention also provides a folding keyboard for use in a pocket computer.

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Brief Description of Drawings

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In drawings illustrating a preferred embodiment of the invention, in which the vertical scale has been exaggerated for ease of illustration:

Fig. 1 is a perspective view of a computer according to a first embodiment of the invention, having a small screen integral with the keyboard, in open configuration;

Fig. 2 is a perspective view of a computer according to the embodiment shown in Fig. 1 in closed configuration;

Fig. 3 is a left side view of a computer according to the embodiment shown in Fig. 1 in open configuration;

Fig. 4 is a top view of a computer according to the embodiment shown in Fig. 1 in closed configuration;

Fig. 5 is a front view of a computer according to the embodiment shown in Fig. 1 in closed configuration;

Fig. 6 is a rear view of a computer according to the embodiment shown in Fig. 1 in closed configuration;

Fig. 7 is a left side view of a computer according to the embodiment shown in Fig. 1 in closed configuration;

Fig. 8 is a left side view of a computer according to the embodiment shown in Fig. 1 in closed configuration;

Fig. 9 is a top plan view of a computer according to the embodiment shown in Fig. 1 in open configuration;

Fig. 10 is an exploded detail view of the hinge shown in Fig. 1;

Fig. 11 is a perspective view of a computer according to a second embodiment of the invention, having a flip-up screen;

Fig. 12 is a perspective view of a computer according to the embodiment shown in Fig. 11 in open configuration with the screen folded down;

Fig. 13 is a perspective view of a computer according to the embodiment shown in Fig. 11 in closed configuration;

Fig. 14 is a left side view of a computer according to the embodiment shown in Fig. 11 in open configuration;

Fig. 15 is a top view of a computer according to the embodiment shown in Fig. 11 in closed configuration;

Fig. 16 is a front view of a computer according to the embodiment shown in Fig. 11 in closed configuration;

Fig. 17 is a rear view of a computer according to the embodiment shown in Fig. 11 in closed configuration;

5 Fig. 18 is a left side view of a computer according to the embodiment shown in Fig. 11 in closed configuration;

Fig. 19 is a right side view of a computer according to the embodiment shown in Fig. 11 in closed configuration;

10 Fig. 20 is a top plan view of a computer according to the embodiment shown in Fig. 9 in open configuration;

Fig. 21 is a perspective view of a computer according to a third embodiment of the invention, having two flip-up screens;

Fig. 22 is a perspective view of a computer according to the embodiment shown in Fig. 21 in open configuration with the screen folded down;

15 Fig. 23 is a perspective view of a computer according to the embodiment shown in Fig. 21 in closed configuration;

Fig. 24 is a front view of a computer according to the embodiment shown in Fig. 21 in closed configuration;

20 Fig. 25 is a rear view of a computer according to the embodiment shown in Fig. 21 in closed configuration;

Fig. 26 is a left side view of a computer according to the embodiment shown in Fig. 21 in closed configuration;

Fig. 27 is a right side view of a computer according to the embodiment shown in Fig. 21 in closed configuration;

25 Fig. 28 is a perspective view of a computer according to a fourth embodiment of the invention in open configuration, having two flip-up screens, each screen folding into two screens making one large screen divided into four equal segments;

Fig. 29 is a perspective view of a computer according to the embodiment shown in Fig. 28 in open configuration with the top two screens folded down;

5 Fig. 30 is a perspective view of a computer according to the embodiment shown in Fig. 28 in open configuration with all four screens folded down;

Fig. 31 is a perspective view of a computer according to the embodiment shown in Fig. 28 in closed configuration ;

10 Fig. 32 is a left side view of a computer according to the embodiment shown in Fig. 28 in open configuration;

Fig. 33 is a front view of a computer according to the embodiment shown in Fig. 28 in closed configuration;

Fig. 34 is a rear view of a computer according to the embodiment shown in Fig. 28 in closed configuration;

15 Fig. 35 is a left side view of a computer according to the embodiment shown in Fig. 28 in closed configuration;

Fig. 36 is a right side view of a computer according to the embodiment shown in Fig. 28 in closed configuration;

Fig. 37 is a detail of a cross-section taken along line C-C of Fig. 3.

20 Fig. 38 is a plan view of a computer according to a fifth embodiment of the invention, having a sliding array of keys, showing the keys in folding configuration;

Fig. 39 is a plan view of the embodiment of the computer shown in Fig. 38 showing the keys in typing configuration;

25 Fig. 40 is a cross-section taken along line A-A of Fig. 39 showing the keys in typing configuration;

Fig. 41 is a cross-section taken along line A-A of Fig. 38 showing the keys in folding configuration; and

Fig. 42 is a cross-section taken along line B-B of Fig. 38.

Best Mode(s) For Carrying Out the Invention

Referring to Fig. 1 through 3 of the drawings, a pocket computer or palm top computer is shown as 10, having a top half 12 and a bottom half 14, hinged at hinge 16 to be foldable from a fully open configuration shown in Fig. 1 to a folded configuration shown in Fig. 2. Computer 10 preferably will be capable of supporting all the applications of a personal computer, such as word processing, spreadsheets, files and folders organization, telephone numbers, addresses, appointment scheduling, access to Internet, etc. Computer 10, for purposes of compactness, need not have a disk drive, power supply or large screen or all the other hardware generally associated with laptop and desktop computers, but still will perform most of the functions of the latter systems, albeit at lesser speeds. Alternatively, the number of functions of the computer can be minimized so as to create a unit which will function exclusively as an Internet Access Device equipped with a screen and full size keyboard. The cost of manufacturing such a device will be a small fraction of the costs of current portable computers having full size keyboards.

According to the invention, the computer 10 has a full-size QWERTY keyboard 18 in frame 15, with an array of keys 17. In the embodiment shown in Fig. 1 the computer has a width of approximately 4 1/4" or somewhat less and a folded length L of 6 1/8" or slightly less, so that it is able to fit comfortably in a shirt pocket, which is typically about 4 1/4" wide and 5" deep, with one end extending out of the pocket. As shown in Fig. 9, keys on a standard personal computer keyboard which are redundant for most applications, such as the numeric keypad, and function keys, are removed. A screen 20 is provided on top half 12. The necessary ports for a modem telephone connection, printer, power supply, computer connection, etc. can be provided along sides 23, 25 or rear edges 27, 29. Battery and CPU microprocessor may be located in compartments 24, 26. The bottom of top half 12 forms a flat surface 13, as does the bottom of bottom half 14. The keyboard 18 folds along fold line 11, which splits the "H" key 13 as shown in the Fig. 1, and the space bar 22. The split "H" keys 13 are located on each side of the fold line 11, and each-half of the split key 13 is an effective key. The two sides of the split letter "H" will both

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be active so that the letter "H" will be typed whether the left side, right side or the two halves are struck together. Double typing of the letter can be avoided either by programming or the keys can be mechanically connected, such as by small male and female connectors, when the unit is in the fully open position. The split space bar
5 22 operates in the same way.

Keys 17 are very thin compared to standard keyboard keys and project preferably equal to or less than approximately 1/16" to 3/64" above the face of the keyboard 18. A key motion of only 1/32" to 3/64" is required. The entire folded computer 10, therefore, can be made extremely thin, i.e. 5/8" to 3/4" thick in the
10 folded position for the embodiment shown in Fig. 1, which will provide sufficient thickness in compartments 24, 26 for the microprocessor and modem. The hinges 16 (shown in more detail in Fig. 10) are located above and below the keyboard 18, carry the electrical connections and allow the two halves of the keyboard to align together precisely when in the open configuration shown in Fig. 1. Keys 17 have vertical
15 sides and are 1/2" wide at the top and the bottom (in a standard keyboards the keys are tapered from 3/4" width at the base to 1/2" width at the top, finger-contacting surface).

The split "H" key 13 is shown in cross-section in Fig. 37, consisting of separate keys 170, 172 on each side of the fold line 11. The keyboard 18 has a
20 base 174, and a keyboard top 176 which retains the keys 17 through openings in which the keys protrude. As in existing electronic keyboards, a flexible mat 178 is provided under the top 176 on which keys 17 sit and which biases keys 17 upwardly so that the shoulders 123 of keys 17 are pressed against the underside of top 176 when not depressed by the user. A printed circuit board 179 is provided between
25 base 174 and mat 178. An electrical contact 180 is provided on the underside of mat 178 under each key 17, so that when the key 17 is depressed, the appropriate electrical circuit is completed in circuit board 179 to signal to the microprocessor that the key has been depressed. Key halves 170, 172 function similarly and are guided in vertical movement by upstanding extensions 182 of base 174.

30 Hinge 16 comprises two halves 122, 124 (Fig. 10) each having three doughnut-shaped hinge elements 126 along opposing edges aligned co-axially and

spaced at opposed locations so that the six hinge elements when interleaved lie along the same axis A. A hinge pin 128 is inserted through the central holes of the hinge elements 126 to hinge the two halves 122, 124 together. The centre of each hinge element 126 is located at the maximum height of the keys on keyboard 18, and also
5 are aligned with the edge 19, 21 of halves 12, 14. In this way the tops of the keys 17 just touch together, but do not squeeze, when the halves 12, 14 are fully closed. Also the edges 19, 21 of the halves are flush when the computer is fully closed.

In the embodiment shown in Fig. 11, computer 30 has top half 32 and bottom half 34 which carry a standard QWERTY keyboard. A flip up screen 36 is
10 provided on bottom half 32 which is pivotable along hinge 38 from a position flat against half 32, as shown in Fig. 12, to the raised position shown in Fig. 11. Keyboard keys 37 are arrayed on both top half 32 and bottom half 34. Again in this embodiment, the keyboard 35 folds along fold line 33, which splits the "H" key 13, and the space bar 22, which split keys operate as described above. The necessary
15 ports for a modem telephone connection, printer, power supply, computer connection, etc. are provided along sides 41,43 or edges 45, 47. Battery and CPU microprocessor are located in compartment 44, 46. The bottom of top half 32 forms a flat surface 39, as does the bottom of bottom half 34. The profile of the embodiment shown in Fig. 11 is tapered to better fit in a shirt pocket. To this end the top edges
20 40 of halves 32, 34 are tapered as shown in Fig. 15.

In the embodiment shown in Fig. 21, computer 50 has two flip-up screens 51, 53 provided on halves 52, 54 which are pivotable along hinges 57, 58 from a position flat against halves 52, 54 as shown in Fig. 22 to the raised position shown in Fig. 5. The embodiment shown in Fig. 21 can also be constructed with
25 screens similar to that in Fig. 21 but with no center frame, but rather abutting screen edges, to improve the continuity of the screen. Keyboard 55 has keys 59 and folds along line 61 in conjunction with hinge 56, as in the Fig. 11 embodiment, with split "H" key 63 and split space bar 64. The necessary ports for a modem telephone connection, printer, power supply, computer connection, etc. are provided along the
30 sides 66, 67 or edges 69, 91 as in the Fig. 11 embodiment. Battery and CPU microprocessor are located in compartments 62, 64. The bottom of top half 52 forms

a flat surface 65, as does the bottom of bottom half 54. The profile of the embodiment shown in Fig. 21 is also tapered to better fit in a shirt pocket as in the embodiment as shown in Fig. 15. To this end the top edges 60 of halves 52, 54 are tapered as shown in Fig. 15.

5 In the embodiment of the invention shown in Fig. 28, computer 70 has four flip up screens 71, 73, 75, 77 provided on halves 72, 74 which are pivotable along hinges 76, 78, 80, and 82, formed along the rear surface thereof by thin joints, from a position flat against halves 72, 74 as shown in Fig. 30, to the semi-raised position shown in Fig. 29, to the fully-raised position shown in Fig. 28. A small
10 hinge 89 shown in detail in Fig. 30A and 31A, partially imbedded in the back of the screens, joins screens 75 and 77 for added strength. The embodiment shown in Fig. 28 can also be constructed with screens with no center frame, but rather abutting screen edges, to improve the continuity of the screen. Keyboard 85 has keys 87 and folds along line 81 in conjunction with hinge 86, as in the Fig. 11 embodiment, with
15 split "H" key 83 and split space bar 84. In this embodiment a small hinge can be provided joining the two space bar sections 84 for added strength. The necessary ports for a modem telephone connection, printer, power supply, computer connection, etc. are provided along sides 93, 95 or edges 97, 99 as in the Fig. 11 embodiment. Compartments 94, 96 are provided to house the modem, batteries, CPU microprocessor and the like. The bottom of top half 72 forms a flat surface 88, as does the
20 bottom of bottom half 74. The profile of the embodiment shown in Fig. 28 is also tapered to better fit in a shirt pocket as in the embodiment as shown in Fig. 15. To this end the top edges 90 of halves 72, 74 are tapered as shown in Fig. 15. The embodiment shown in Fig. 28 is particularly suitable for applications such as
25 EXCEL™ which require four screen sections. Further, it can be constructed using software so that the lettering is justified on each of the screen sections, and positioning the horizontal joint between lines of text, so that the break between the four sections will not interfere with the legibility of the documents. The screens can be lit by light sources along the exterior frame.

30 In the embodiments of Fig. 11, 21 and 28, as in the Fig. 1 embodiment, the computer has a maximum width of approximately 4 1/4", and a folded length of

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approximately 6 -1/8". The tapered end of the computer has a minimum width of 3 7/8". It will be apparent to those skilled in the art that the thickness of the folded computer shown in Fig. 13, 23 and 31 is necessarily greater than the Fig. 2 embodiment due to the added thickness of the liquid crystal screen or screens, which are a liquid crystal film sandwiched between two pieces of structural glass or high impact plastic with a thickness of about 3/16" or less. Four such screens, as in the Fig. 28 embodiment, will total a thickness therefore of about 3/4" or less. The total folded thickness, for example, of the Fig. 11 embodiment is under 3/4" -- about 1/4" for each computer half 32, 34, plus 3/16" for the screen section, and the folded thickness of the Fig. 1 embodiment is under 1/2".

In a further embodiment illustrated in Fig. 38 through 42, the folding keyboard can be achieved by sliding certain keys rather than splitting keys to permit a folding keyboard. The groups of letters "QWER", "ASDF" and "567890-=" are movable on carriages 152, 154, 156 and slide from a folding position shown in Fig. 38 to a typing position shown in Fig. 39. In the typing position, the carriages 152, 154, 156 carrying the groups of letters will be locked into the normal keyboard locations. In order to re-fold the keyboard, the carriages 152, 154, 156 are moved to the position shown in Fig. 38 and locked in that position. The "Tab", "Caps Lock" and " " keys may be extendible to fill in the gaps created by the sliding into the "Typing Position". In the Fig. 38 embodiment, the computer 100 has body 119 and a screen 120 at one end of the keyboard, and hinges 116 on fold line 117.

Carriage 154 is shown in cross-section in Fig. 40 and 41. Keys 122 are provided with a plastic roller 184, and are retained by plastic top 183. Flexible mat 186 is flat to permit rolling or sliding of carriage 154, and again carries on its underside electrical contacts 188 which form a circuit with circuit board 199 when keys 122, when in the typing position shown in Fig. 39, are depressed. Plastic infill pieces 190, 92 form a surface on which the carriage 54 can slide or roll. The "F" key 185 has two rollers 84 to contact separate electrical contacts 188. In Fig. 40 the carriage 154 is in typing position, whereas in Fig. 41 the carriage 154 has been moved to the folding position to permit folding along line 117.

Another alternative to achieving a folding keyboard without splitting keys, rather than using sliding keys, would be to leave the keys fixed in the position shown in fig. 39, leaving a jagged edge 17 along the fold line, which is less aesthetically pleasing but still operable to permit a folding keyboard.

- 5 As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.

WHAT IS CLAIMED IS:

1. A folding pocket-sized computer, comprising a screen, a central processing unit, data storage means and data input means, said data input means
5 comprising a computer keyboard comprising a plurality of keys generally corresponding in spacing, size and location to the keys of a standard personal computer keyboard, and comprising two halves hingedly connected along a fold line extending transversely across said keyboard, each half thereby comprising a portion of said plurality of keys, whereby said computer is
10 folded from a first open position in which said plurality of keys forms said generally standard personal computer keyboard, to a closed position in which said two halves are in opposed parallel relationship whereby said respective portions of said plurality of keys on said respective halves face each other in close proximity or actual contact.
15
2. The folding computer of claim 1 wherein at least one of said keys is split along said fold line to permit folding of said keyboard.
3. The folding pocket-sized computer of claim 2, wherein said screen comprises
20 a screen section pivotally connected to one of said keyboard sections.
4. The folding pocket-sized computer of claim 3, wherein said screen comprises two screen sections, each pivotally connected to one of said keyboard sections.
- 25 5. The folding pocket-sized computer of claim 4, wherein said screen comprises four screen sections, a first and a second screen section each pivotally connected to one of said keyboard sections and a third and a fourth screen section each pivotally connected to one of said first and second screen sections.
30

6. A folding computer keyboard, comprising a plurality of keys generally corresponding in spacing, size and location to the keys of a standard personal computer keyboard, and comprising two halves hingedly connected along a fold line, whereby one of said keys is split along said fold line to permit
5 folding of said keyboard; wherein said hinged connection is formed by each half having a plurality of hinge elements along opposing edges aligned co-axially and spaced at opposed locations so that said hinge elements when interleaved lie along the same axis, each hinge element having a central aperture, and a hinge pin inserted through said central apertures of the hinge
10 elements to secure the two halves, the centre of each hinge element being located at the maximum height of each keyboard half.
7. The folding computer keyboard of claim 1 wherein said keys have a vertical travel distance equal to or less than 1/32".
- 15 8. A folding pocket-sized computer, having dimensions when folded less than 4" x 7" and providing when opened a computer keyboard, comprising a plurality of keys generally corresponding in spacing, size and location to the keys of a standard personal computer keyboard.
- 20 9. The folding pocket-sized computer of claim 1 wherein the number of functions of the computer is minimized so as to create a unit which will function exclusively as an Internet Access Device.
- 25 10. A folding computer keyboard, comprising a plurality of keys generally corresponding in spacing, size and location to the keys of a standard personal computer keyboard, and comprising two halves hingedly connected along a fold line, whereby a plurality of keys are reversibly movable from a folding position to a typing position, wherein said hinged connection is formed by
30 each half having a plurality of hinge elements along opposing edges aligned co-axially and spaced at opposed locations so that said hinge elements when

interleaved lie along the same axis, each hinge element having a central aperture, and a hinge pin inserted through said central apertures of the hinge elements to secure the two halves, the centre of each hinge element being located at the maximum height of each keyboard half.

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11. A folding pocket-sized computer, comprising a screen, a central processing unit, data storage means and data input means, said data input means comprising a computer keyboard comprising a plurality of keys generally corresponding in spacing, size and location to the keys of a standard personal computer keyboard, and comprising two halves hingedly connected along a fold line, whereby a plurality of keys are reversibly movable from a folding position to a typing position, wherein said hinged connection is formed by each half having a plurality of hinge elements along opposing edges aligned co-axially and spaced at opposed locations so that said hinge elements when interleaved lie along the same axis, each hinge element having a central aperture, and a hinge pin inserted through said central apertures of the hinge elements to secure the two halves, the centre of each hinge element being located at the maximum height of each keyboard half.

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12. A folding computer keyboard, comprising a plurality of keys generally corresponding in spacing, size and location to the keys of a standard personal computer keyboard, and comprising two halves hingedly connected along a fold line, whereby a plurality of keys are reversibly movable from a folding position to a typing position.

25

13. The folding computer keyboard of claim 12 wherein said plurality of movable keys move uniformly as a first group.
14. The folding computer keyboard of claim 13 wherein said plurality of movable keys move as two uniformly moving groups.

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15. The folding computer keyboard of claim 14 wherein said plurality of movable keys move as three uniformly moving groups.
16. A folding pocket-sized computer, comprising a screen, a central processing unit, data storage and input means and a computer keyboard comprising a plurality of keys generally corresponding in spacing, size and location to the keys of a standard personal computer keyboard, and comprising two halves hingedly connected along a fold line, whereby a plurality of keys are reversibly movable from a folding position to a typing position.

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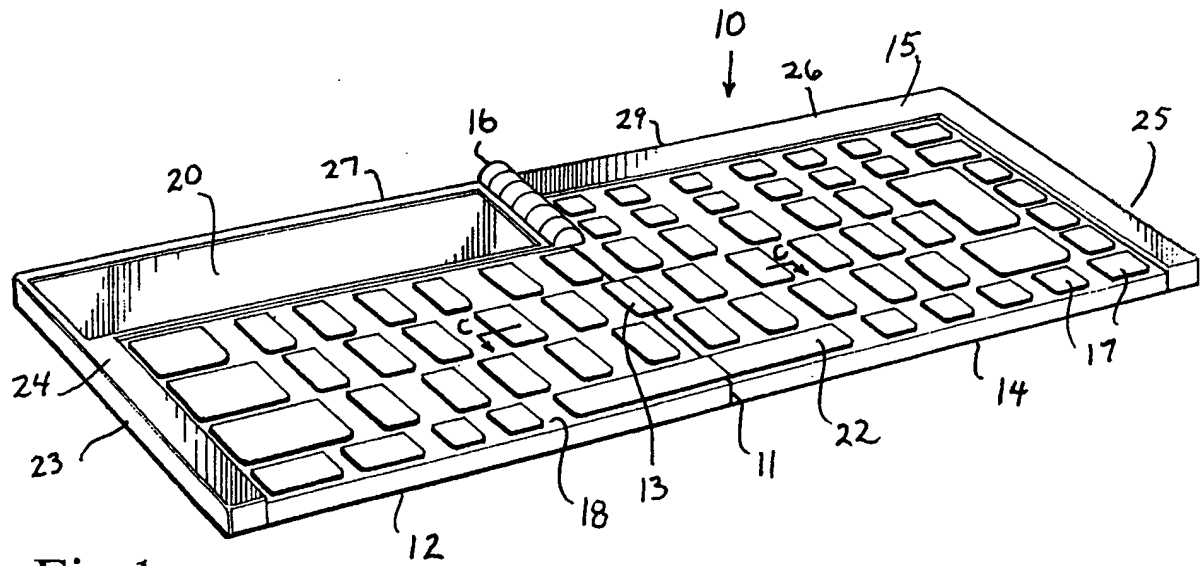


Fig. 1

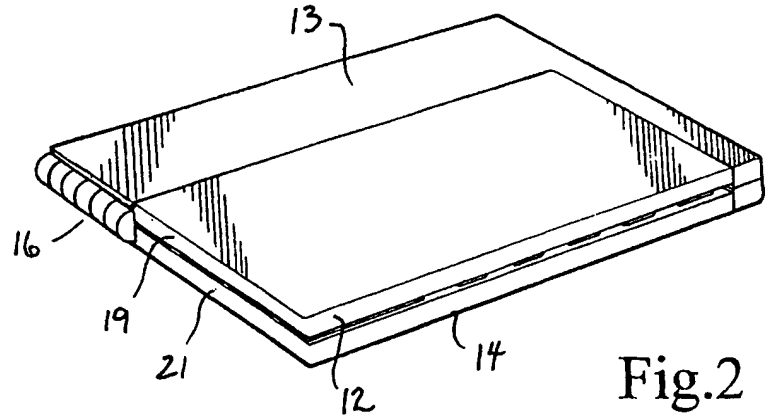


Fig. 2

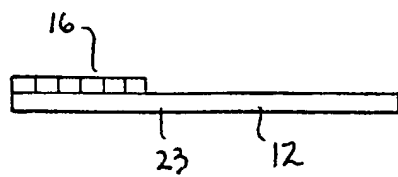


Fig. 3

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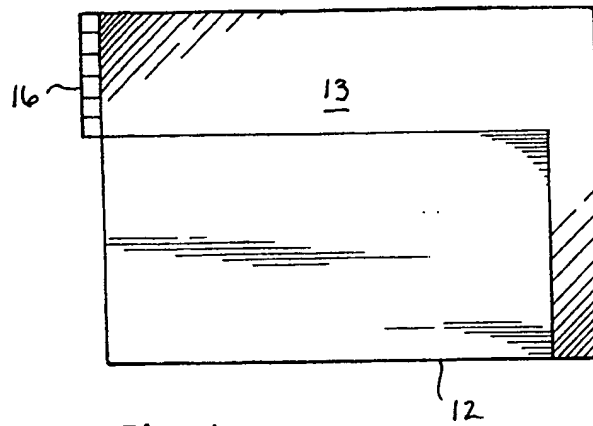


Fig. 4

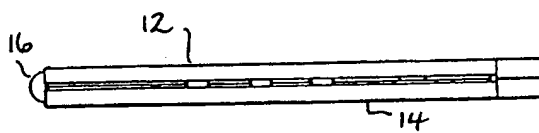


Fig. 5

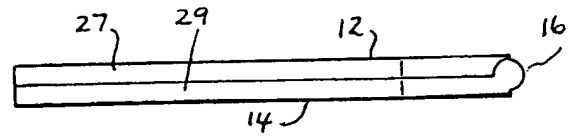


Fig. 6

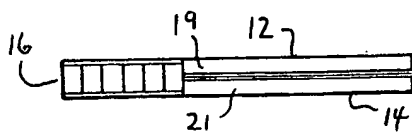


Fig. 7

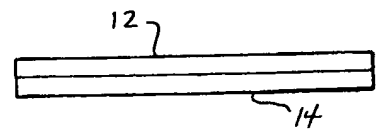


Fig. 8

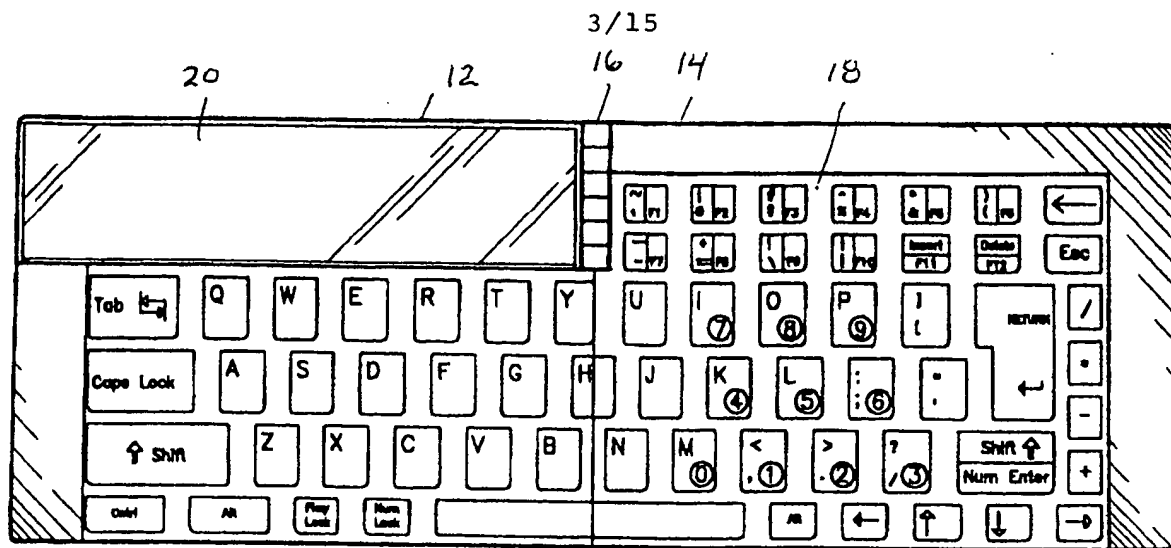


Fig.9

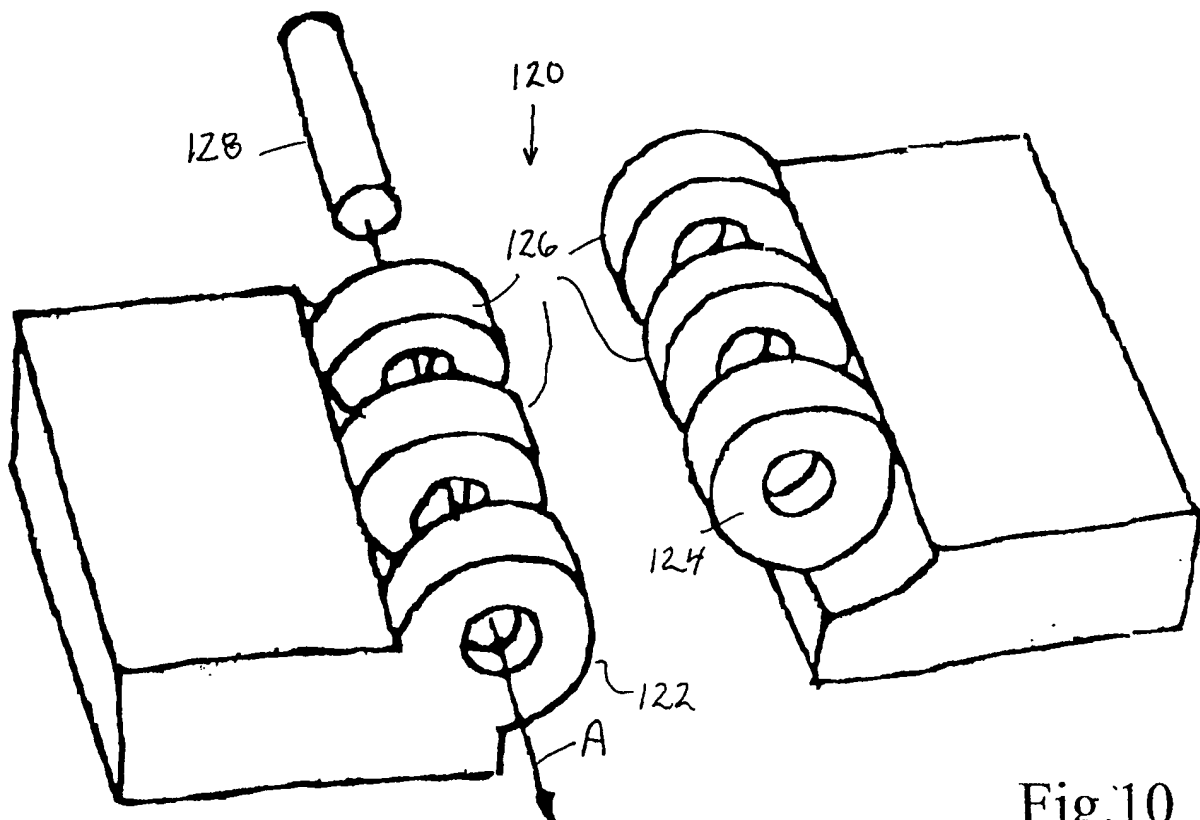


Fig.10

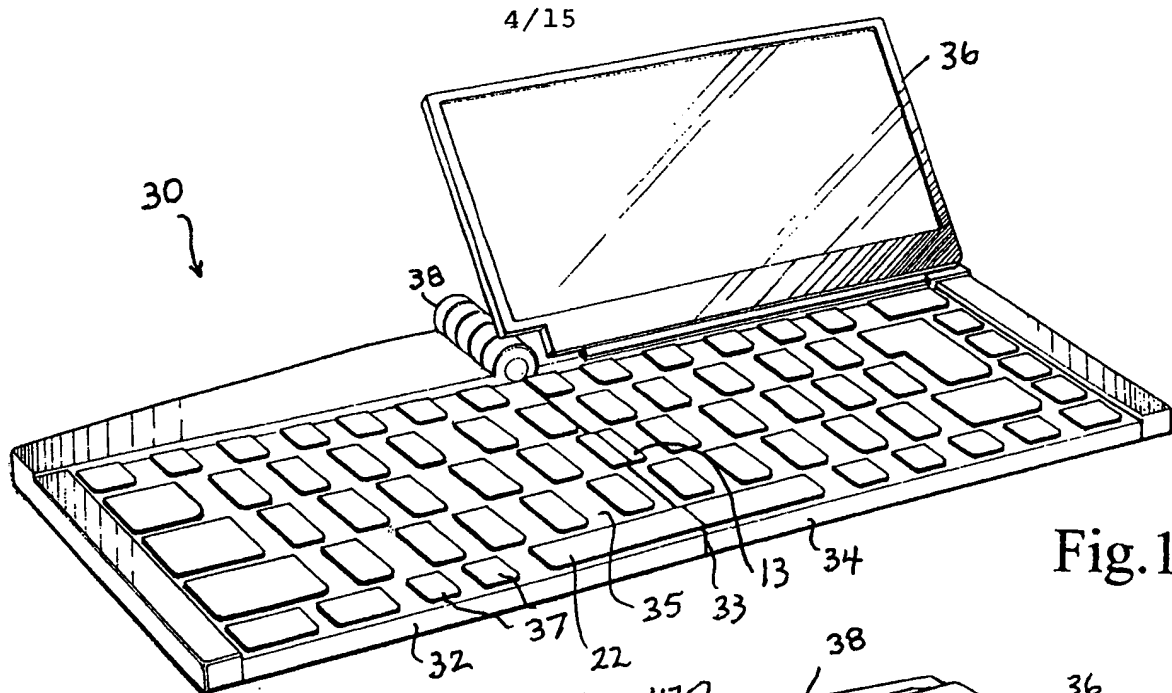


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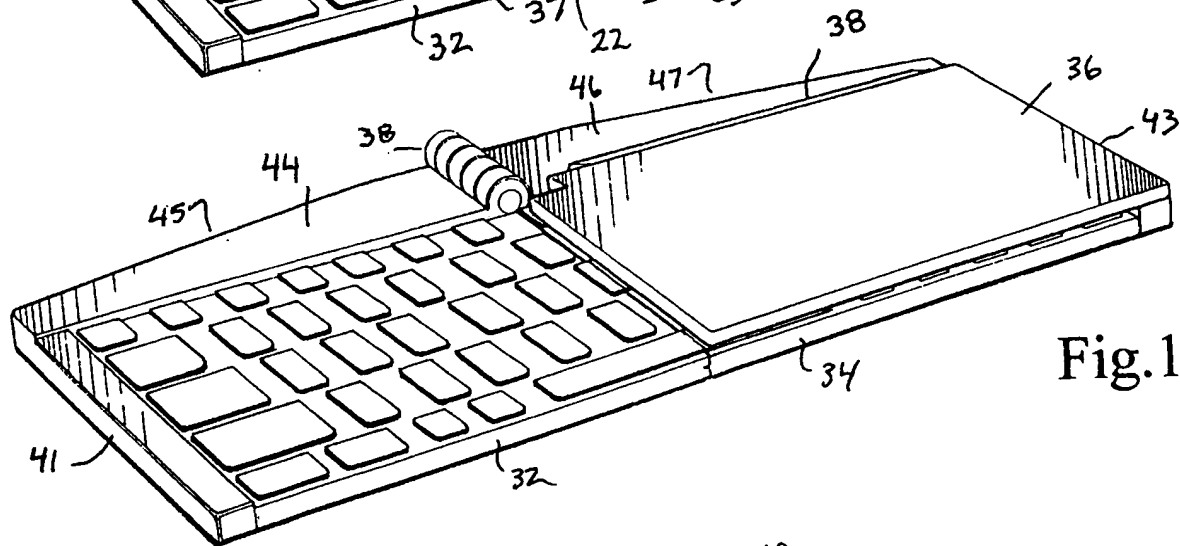


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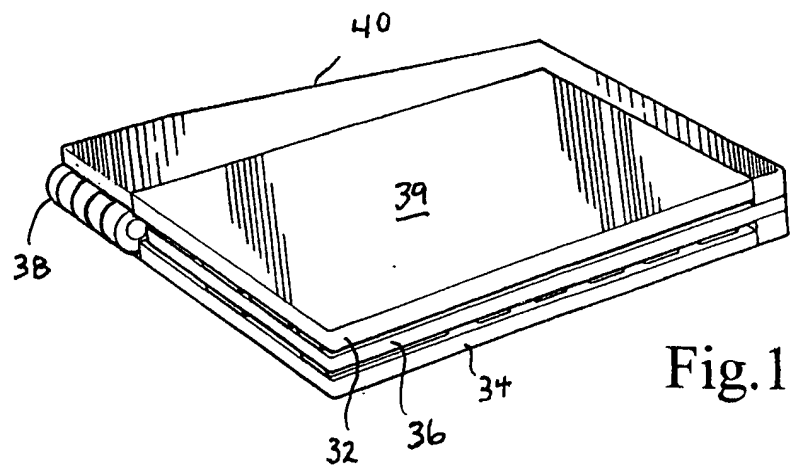


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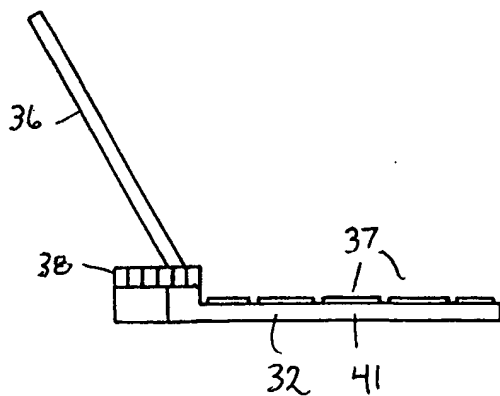


Fig. 14

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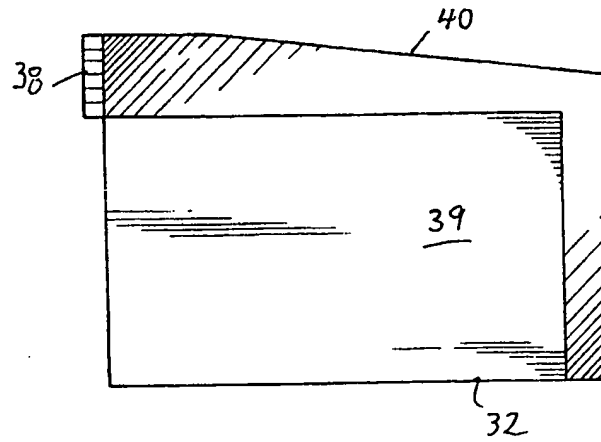


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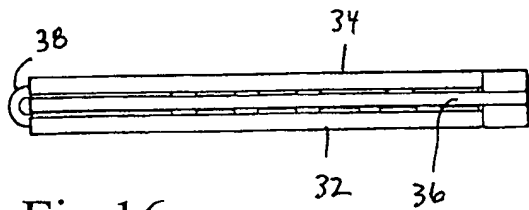


Fig. 16

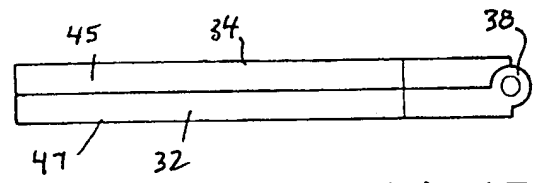


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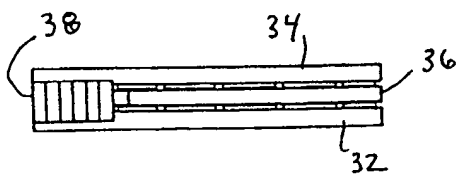


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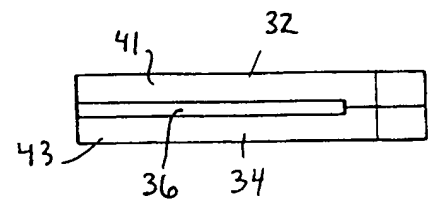


Fig. 19

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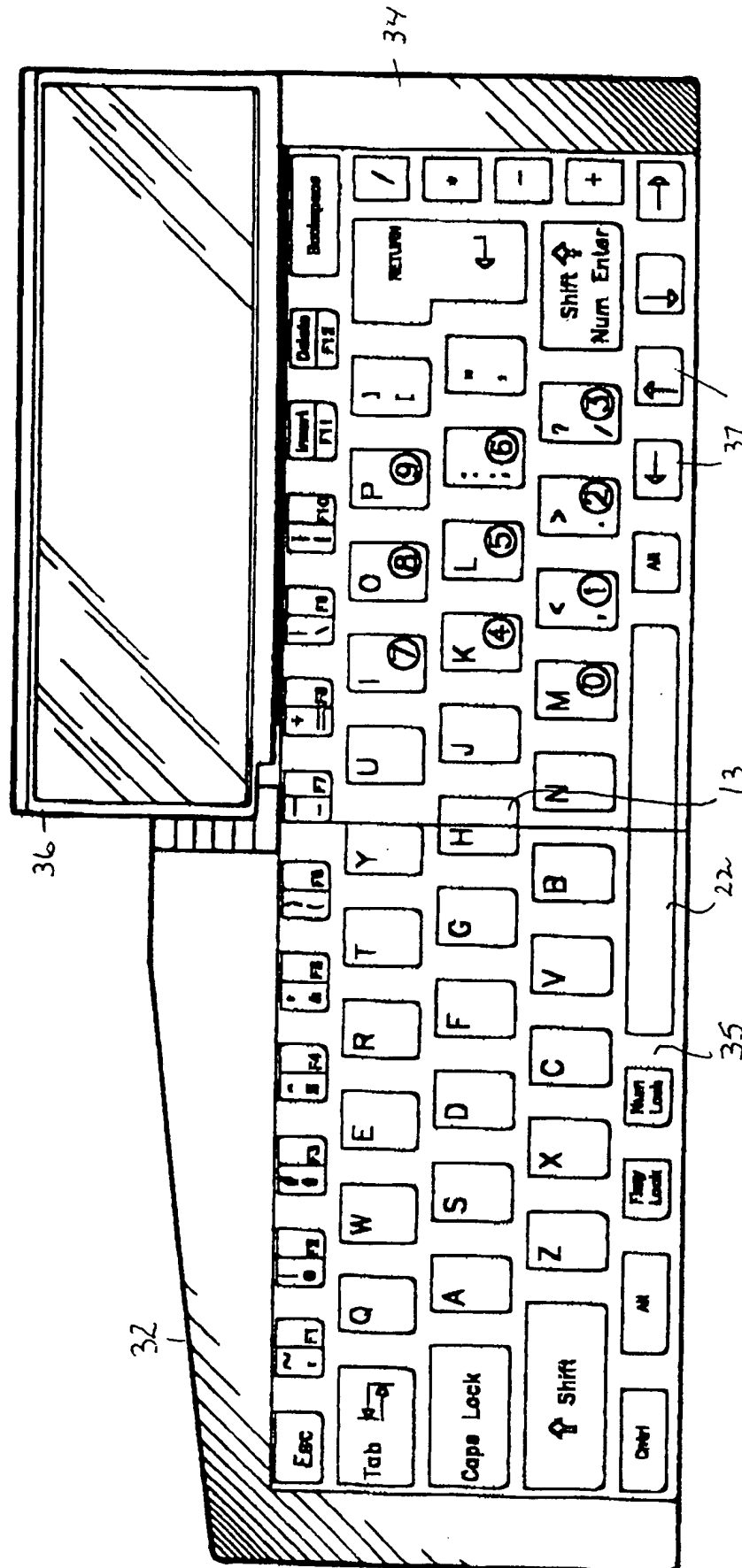


Fig. 20

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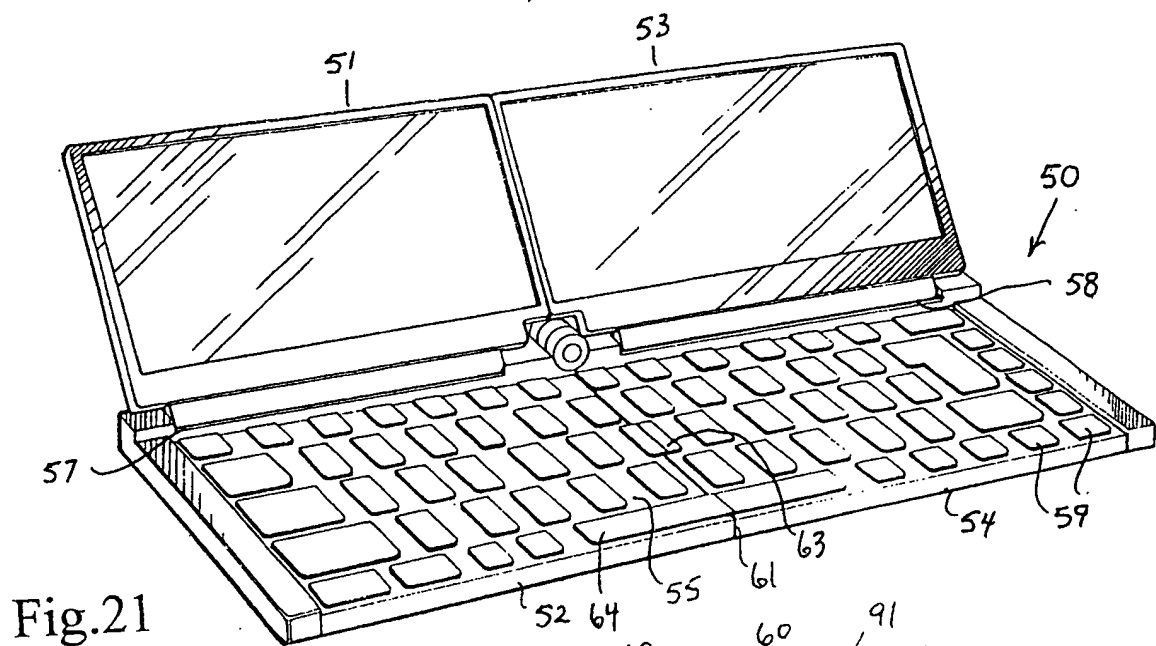


Fig.21

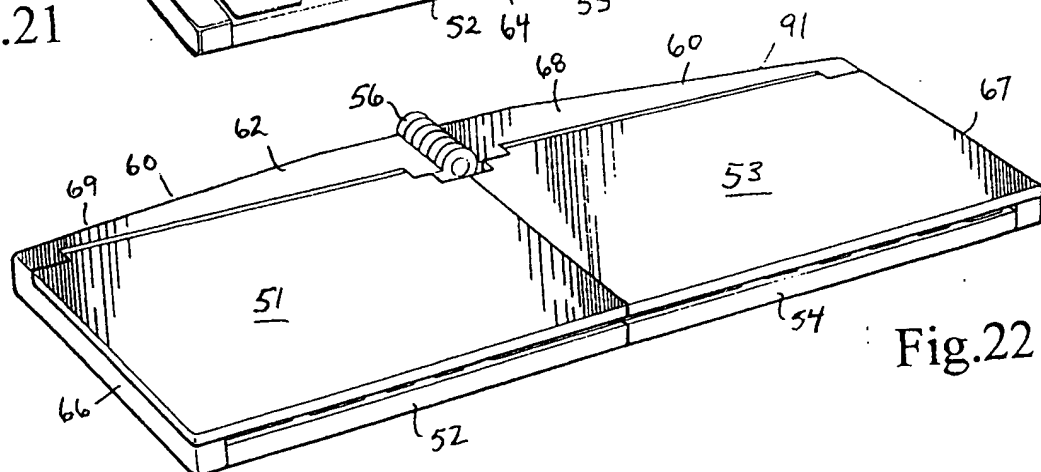


Fig.22

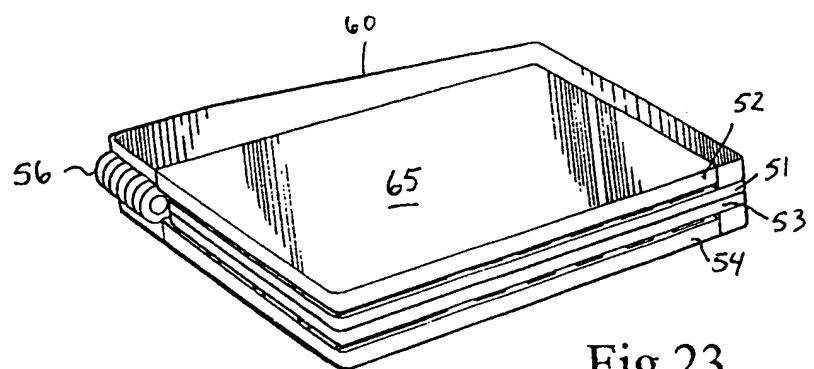


Fig.23

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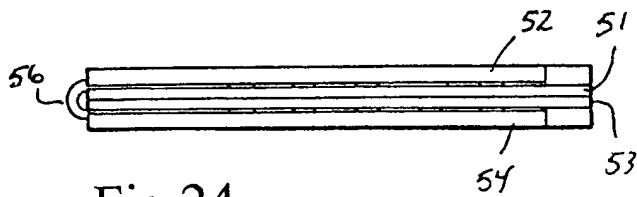


Fig.24

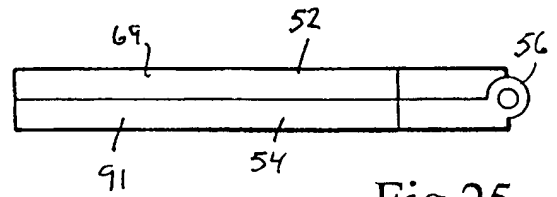


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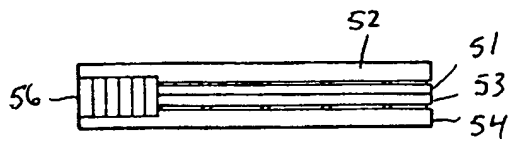


Fig.26

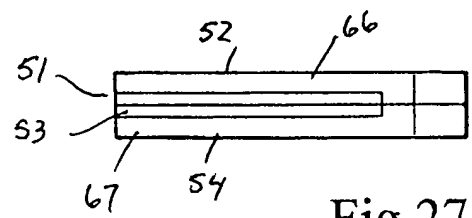


Fig.27

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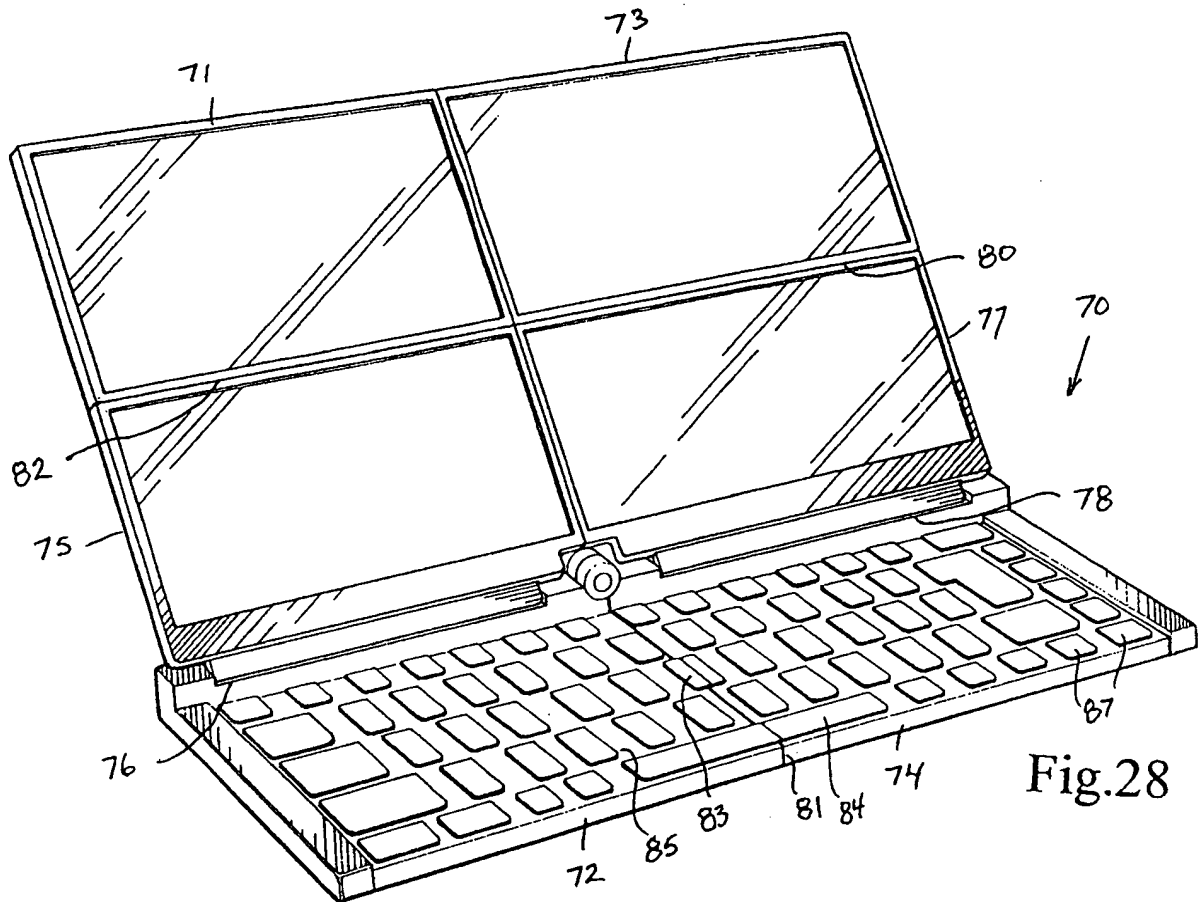


Fig. 28

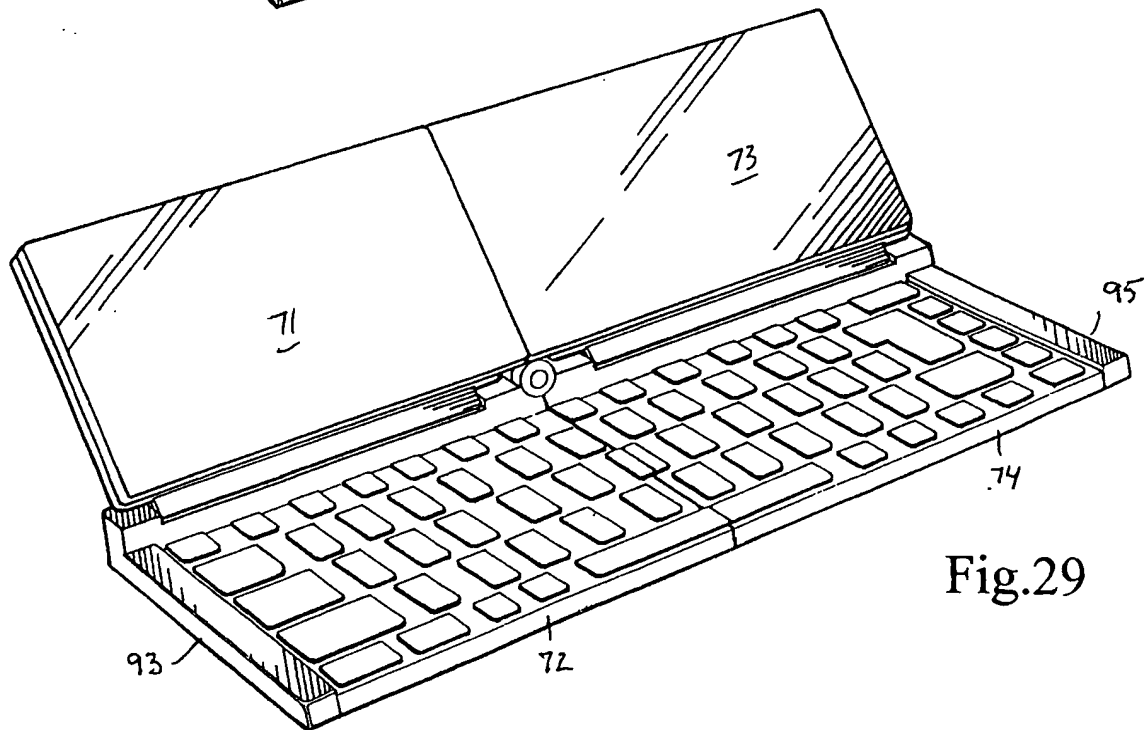


Fig. 29

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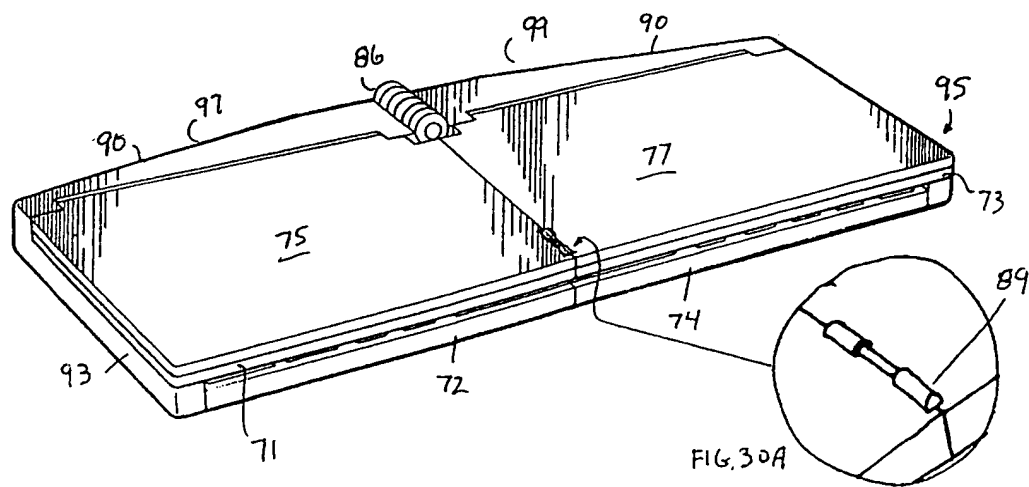


Fig. 30

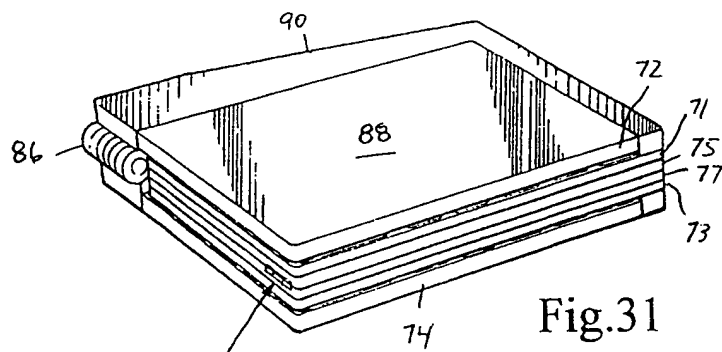


Fig. 31

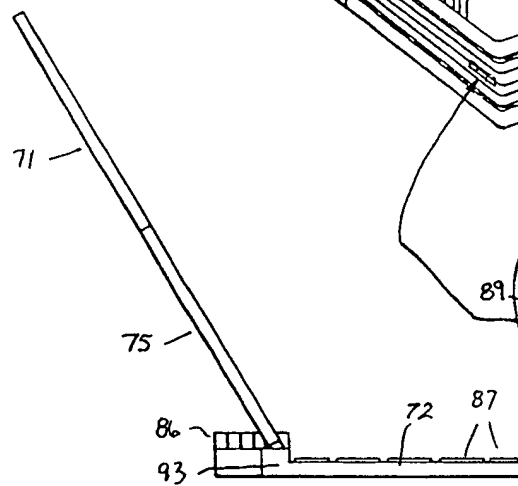


Fig. 32

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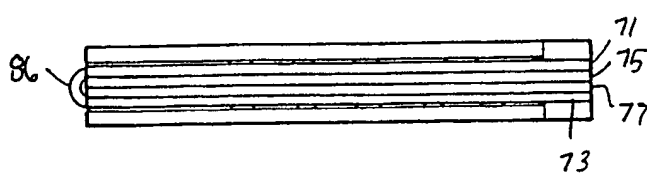


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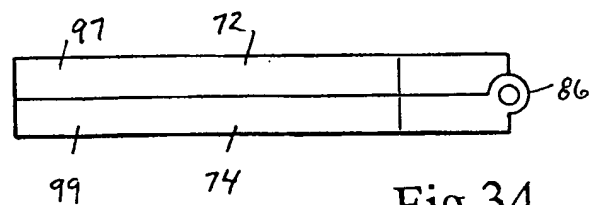


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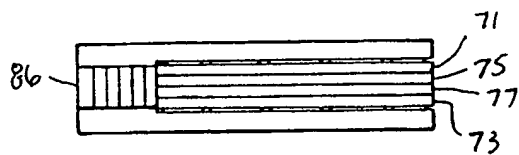


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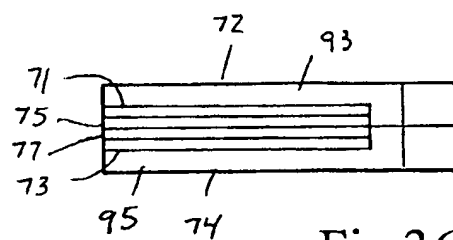
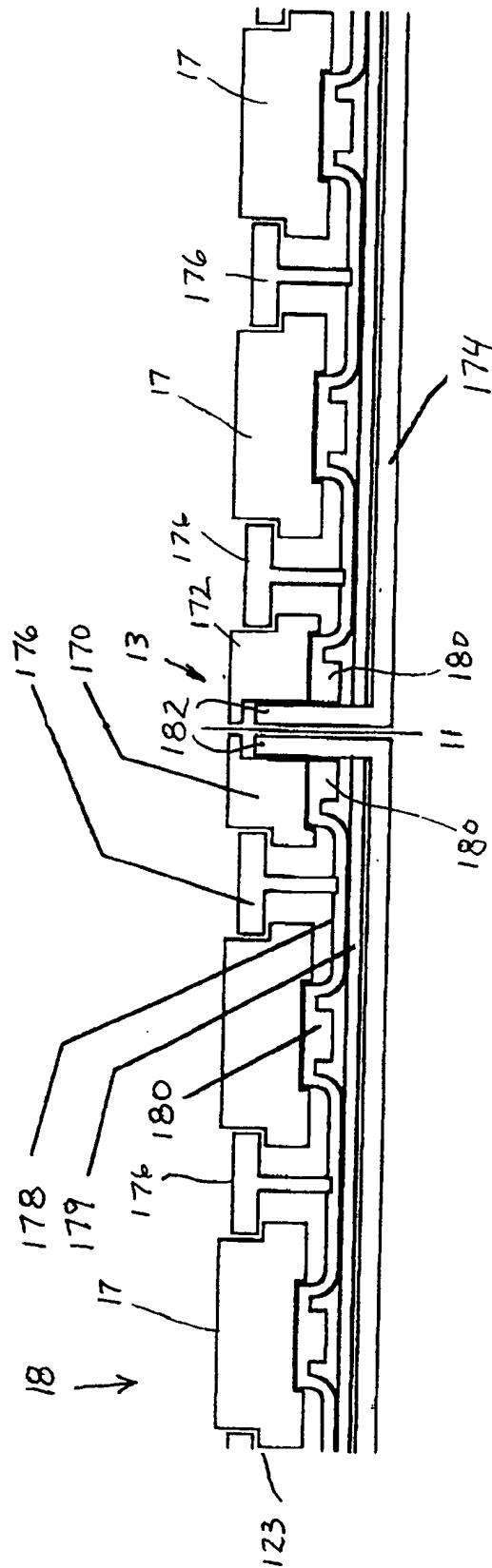


Fig.36



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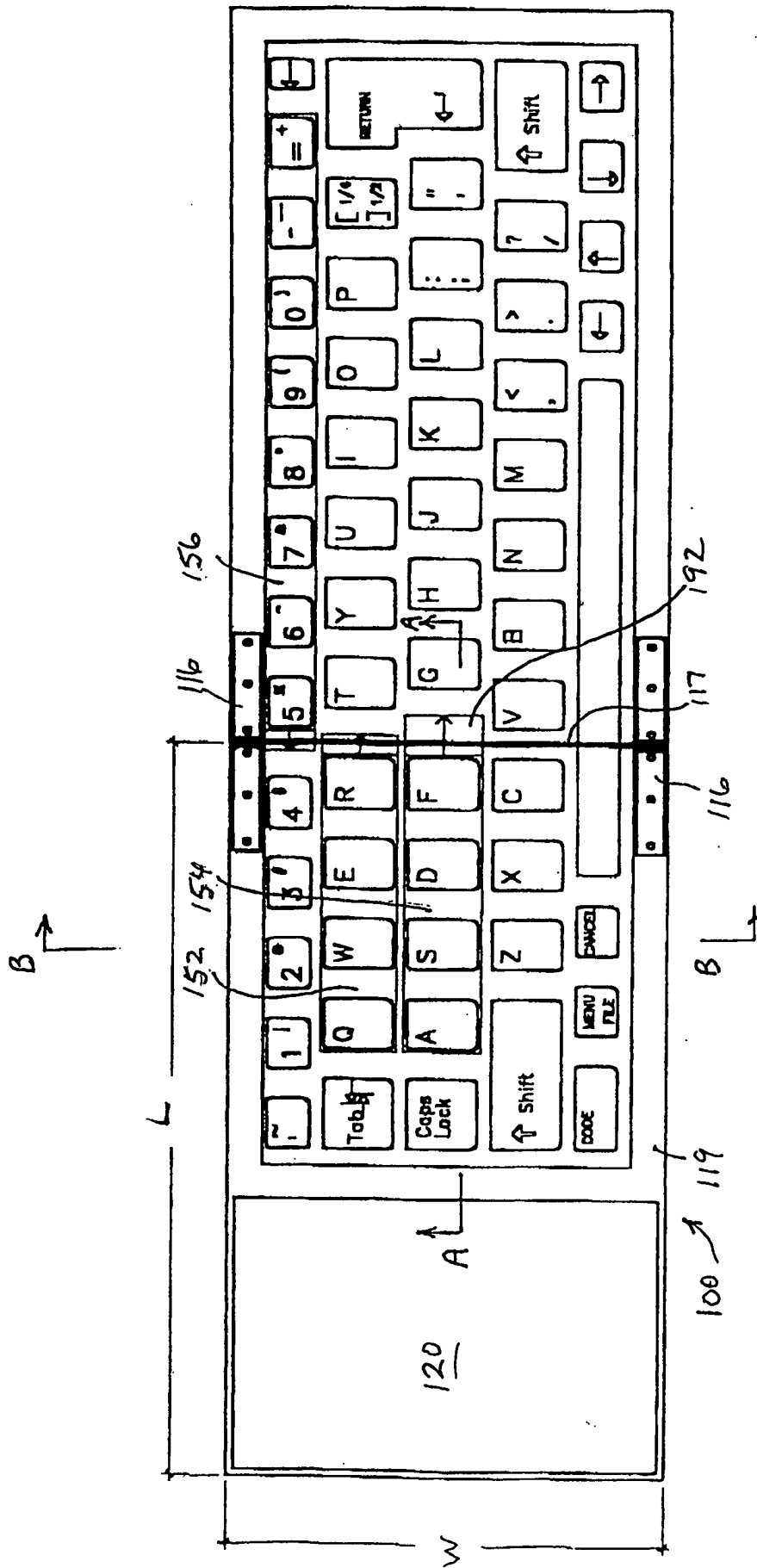


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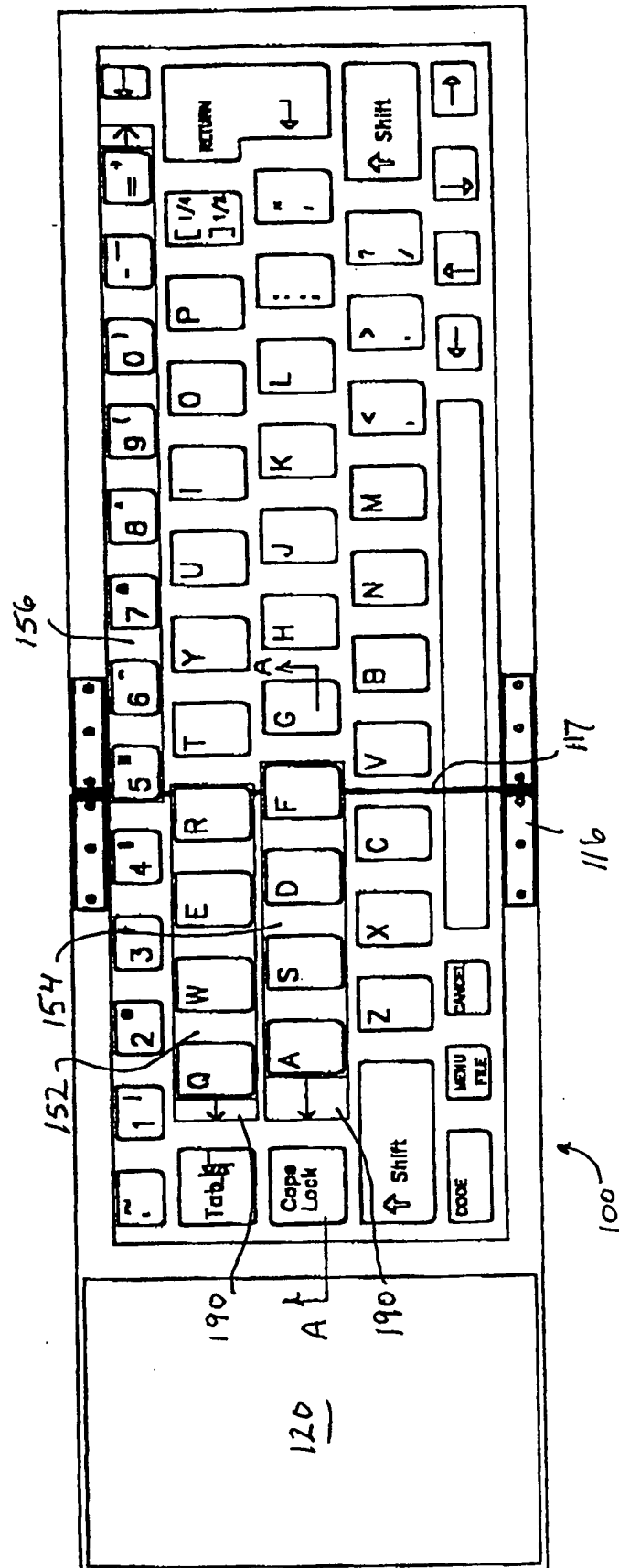


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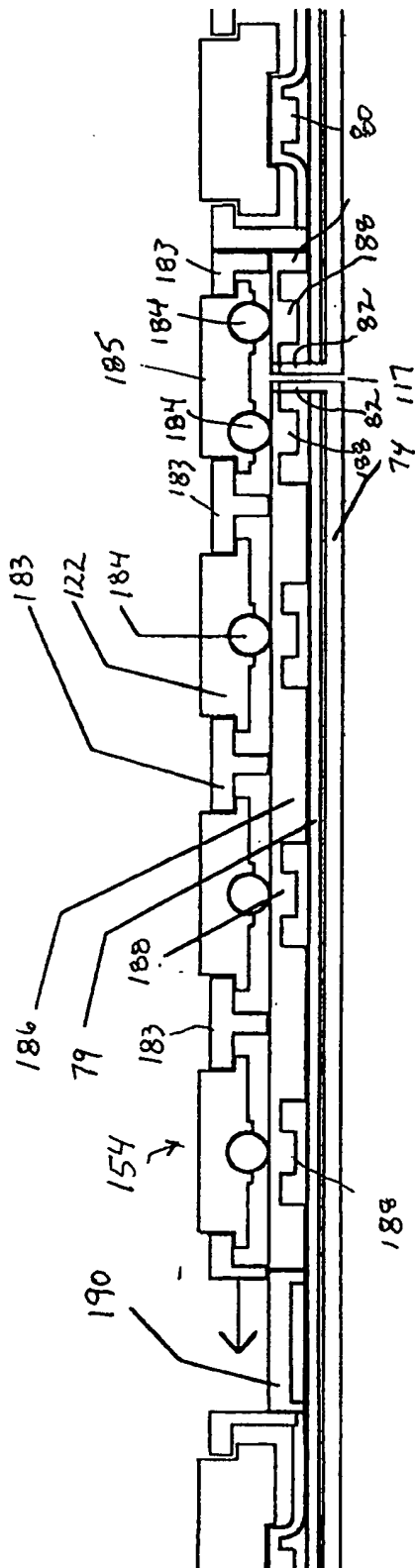


Fig. 40

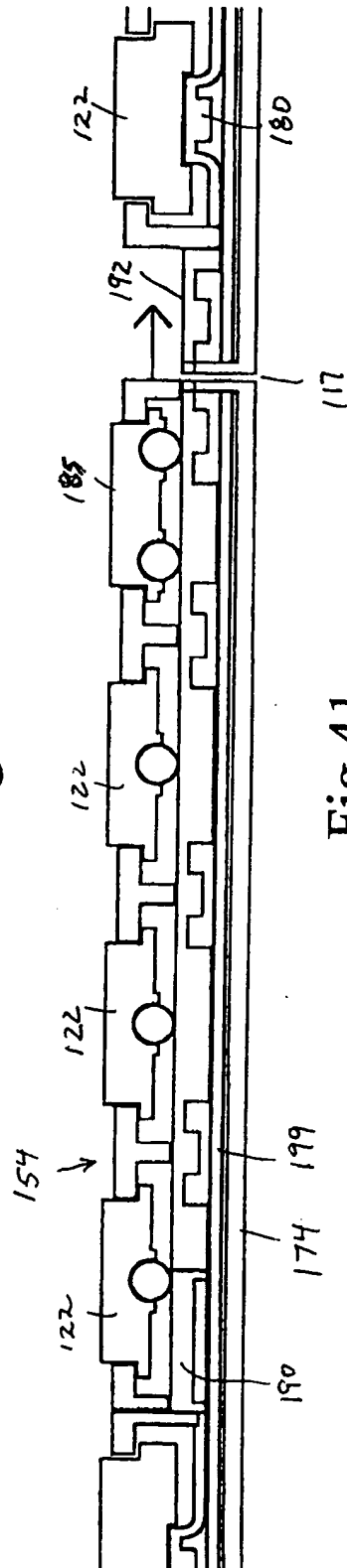


Fig. 41

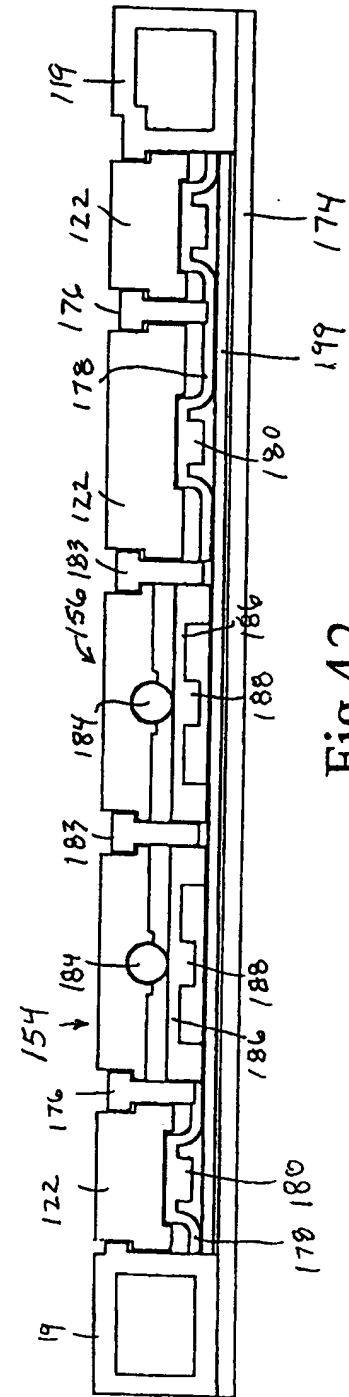


Fig. 4.2

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